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DRAFT

Remedial Action Plan for the Expanded Bioventing System Hurlburt Field Fire Training Area



**Eglin Air Force Base
Florida**

Prepared For

**Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas**

and

**AFDTC / EMR
Eglin Air Force Base
Florida**

August 1996



**PARSONS
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**REMEDIAL ACTION PLAN
FOR THE EXPANDED BIOVENTING SYSTEM
AT HURLBURT FIELD FIRE TRAINING AREA,
SITE FT-39
EGLIN AIR FORCE BASE, FLORIDA**

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE

BROOKS AIR FORCE BASE, TEXAS

AND

AFDTC/EMR

EGLIN AIR FORCE BASE, FLORIDA

AUGUST 1996

Prepared by:

PARSONS ENGINEERING SCIENCE, INC.

ATLANTA, GEORGIA

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1. INTRODUCTION

This remedial action plan (RAP) presents the scope for an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at the Hurlburt Field Fire Training Area (Hurlburt Field FTA) at Eglin Air Force Base (AFB), Florida. This site is also identified as Installation Restoration Program (IRP) Site FT-39. The proposed expanded system activities will be performed by Parsons Engineering Science, Inc. (Parsons ES) [formerly Engineering-Science, Inc. (ES)] for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under Contract No. F41624-92-D-8036, Delivery Order No. 0017. The primary objectives of the bioventing system upgrade are to:

- Continue aerobic *in situ* remediation of fuel-contaminated soils by injection of atmospheric air into soil;
- Sustain aerobic *in situ* biodegradation until hydrocarbon-contaminated soils within the unsaturated zone are remediated to below regulatory approved standards; and
- Provide additional site characterization data for closure.

An extended bioventing pilot test was performed at Hurlburt Field FTA from March 1994 through July 1995 to determine if *in situ* bioventing would be a feasible cleanup technology for the fuel-contaminated soils within the unsaturated zone. A radius of oxygen influence of at least 40 feet was observed at the site. Further details on the pilot test procedures and results can be found in the Interim Pilot Test Results Report (ES, 1994).

Following the extended pilot test, soil and soil gas data confirmed significant contaminant removal in the pilot test area. Based on laboratory results from soil and soil gas samples, significant reductions in total volatile hydrocarbons (TVH), and benzene, toluene, ethylbenzene, and xylenes (BTEX) were observed in soil gas, and significant reductions in total recoverable petroleum hydrocarbon (TRPH) and BTEX concentrations were observed in soil over the extended pilot test period. In addition, the extended pilot test demonstrated that significant oxygen utilization and biodegradation are continuing at the pilot test locations, and that continued bioventing will sustain the biodegradation. Further details on the pilot test results are presented in Section 3. The success of bioventing at this site supports the recommendation of an expanded (full-scale) bioventing system as the most economical approach of remediating the remaining hydrocarbon-contaminated soils in the vicinity of the Hurlburt Field FTA.

This RAP addresses soil contamination associated with burning of waste fuels at the Hurlburt Field FTA. Site investigation data collected to date indicate that the majority of soil contamination exists in the upper 8 feet of subsurface soil. The source of

contamination is the burn pit (approximately 50 feet in diameter). Available historical data indicate contamination in the soil extends beyond the perimeter of the burn pit and beyond the surrounding asphalt area, northeast of the burn pit. The proposed expansion of the bioventing system will provide oxygen to all contaminated soil to facilitate biodegradation of petroleum hydrocarbons.

Pilot test data have been used to design the expanded bioventing system to remediate contaminated soils. The expanded system will consist of the existing air injection vent well (VW) and three new VWs to deliver oxygen throughout the remaining unsaturated fuel-contaminated soils. Six new vapor monitoring points (VMPs) will also be constructed to monitor contaminant reduction and oxygen influence in the soil gas. The expanded bioventing system will target smear zone contamination as well as vadose zone contamination.

This document is divided into eight sections including this introduction, and one appendix. Section 2 discusses site background and includes a discussion of existing site characterization data. Section 3 provides the results of the extended pilot test conducted at the Hurlburt Field FTA. Section 4 identifies the treatment area of the proposed expanded system; provides construction details of the expanded system; and recommends a proven, cost-effective approach for the remediation of the remaining hydrocarbon-contaminated soils at the site. Procedures for handling investigation-derived waste are described in Section 5, and Base support requirements are listed in Section 6. Section 7 provides key points of contact at Eglin AFB, AFCEE, and Parsons ES; and Section 8 provides the references cited in this document. A design package for the expanded bioventing system is provided in Appendix A.

2. SITE BACKGROUND

2.1 SITE LOCATION

The Hurlburt Field FTA is located approximately one mile west of Mary Esther, Florida. To reach the FTA, exit Eglin Main Base via the west access gate onto State Route #85. Proceed 3.4 miles and take State Route #20 west near Ocean City. Follow this road, also known as Racetrack Road, for 3 miles into the City of Wright. Enter Hurlburt Field on Heritage Road. This road will intersect Golf Course Road within 2.3 miles of the base boundary. Turn left onto Golf Course Road, travel less than 0.1 mile, and turn right into the Golf Course Maintenance Facility (GCMF). Turn right onto the gravel road which intersects the GCMF driveway. Follow the gravel road for approximately 400 feet and turn left into the FTA (Figure 2.1).

2.2 SITE DESCRIPTION

The Hurlburt Field FTA is defined by a large, cleared circular area with a earthen berm nearly 6 feet in height to the east. The burn area is currently inactive and measures approximately 75 feet in diameter with a 6-inch concrete berm along the periphery for fuel containment. An asphalt apron, approximately 50 feet in width, surrounds the burn pit. The 6-inch concrete berm is part of a concrete liner system constructed beneath the burn pit and was designed to collect residual fuels, water, and AFFF (an extinguishing agent). Collected fluids flowed to an oil/water separator near the southern edge of the site and were removed. Effluent from the oil/water separator discharged to a drainage ditch leading to a nearby swamp.

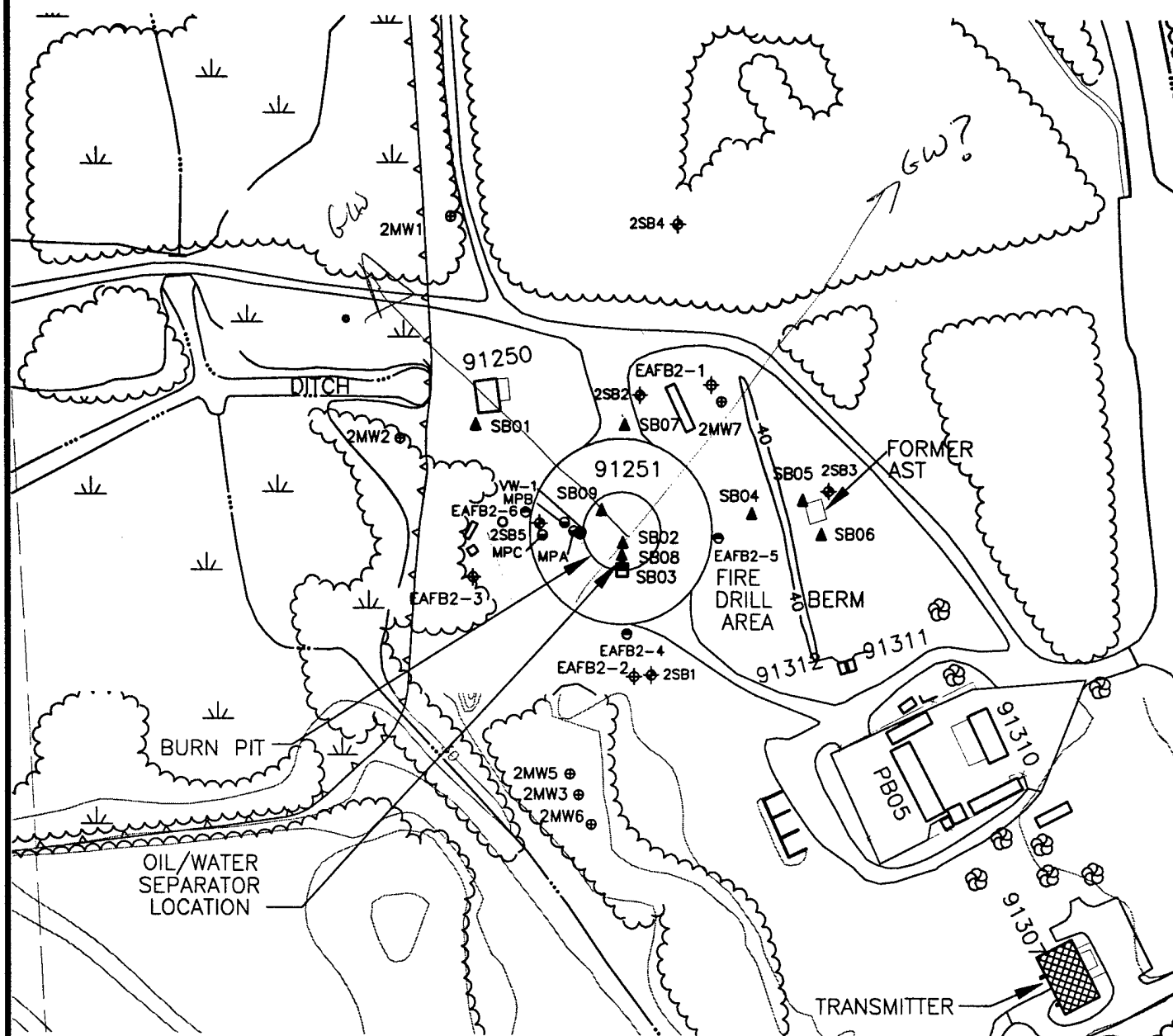
The site is in an isolated area on the eastern side of Hurlburt Field N-S runway. The site is currently being used as a practice area for the sheet metal repair of military aircraft. Several aircraft are positioned on the asphalt apron for the practice sessions.

2.3 OPERATIONAL HISTORY

The Hurlburt Field FTA site was used for the training of personnel in the Fire Protection Division Department and the disposal of waste fuels, oils, solvents, and contaminated fuels. The site was active from the late 1950s to 1989, however, the frequency of use in recent years was greatly reduced from the typical two to three fires per week prior to the mid 1960s. Furthermore, pollution concerns caused a reduction in the quantities of fuels used and limited the extinguishing agent to primarily water.

The common practice used during training exercises involved spraying fuel onto representative mock buildings, planes, and cars. Since the burn pit was originally equipped with a concrete berm, much of the fuel remained confined and was easily

SITE LAYOUT MAP HURLBURT FIELD FTA (FT-39) EGLIN AFB, FLORIDA



Legend

- ⊕ Phase II Stage 2 Monitoring Well (1988)
- ⊙ Phase II Stage 2 Soil Boring (1988)
- ⊕ Phase II Stage 3 Monitoring Well (1992)
- ⊕ Phase II Stage 3 Soil Boring (1992)
- Vent Well (1992)
- ⊙ Monitoring Point (1994)
- ▲ RFI Soil Boring (1995)

- ROADWAY
- 91310 BUILDING NUMBER
- FENCE
- CANAL
- TREE LINE
- TOP OF BANK

150 0 150
APPROX. SCALE IN FEET



ignited. After a specified time, chemicals (AFFF and/or water) were applied to extinguish the fire. Ideally, any unburned fuel was then diverted to the nearby oil/water separator. Discharge from the separator then flows southwest to a drainage ditch leading to Hurlburt Lake.

2.4 SITE GEOLOGY AND HYDROGEOLOGY

Three predominant geologic features underlie the Hurlburt Field FTA: the sand-and-gravel aquifer, the Pensacola Clay formation, and the limestones comprising the Floridan aquifer system. The surficial sands and gravels extend to an approximate depth of 390 feet bgs. The underlying Pensacola Clay is approximately 280 feet thick in the area and extends to a depth of approximately 670 feet bgs (ES, 1992). Groundwater is encountered at seasonally fluctuating depths of approximately 4 to 8 feet bgs. Depth to groundwater at the edge of the burn pit is higher (about 8 ft bgs) because the fire training pit area was built higher than surrounding areas. Because the bioventing technology is applied to the unsaturated soils, this section will address primarily soils above the shallow aquifer. Soils at this site, to a depth of 390 feet below ground surface (bgs), consist of predominantly unconsolidated, poorly to moderately well sorted, fine-to-medium and coarse-grained sand with large amount of shell fragments in the upper 5 feet. The generally homogeneous, sandy material at this site is well suited to bioventing treatment, as was demonstrated during the initial 1-year bioventing pilot test.

The sand-and-gravel aquifer occurs under unconfined or water table conditions at the site. The generalized groundwater flow direction in the surficial aquifer is towards the northwest as indicated by past groundwater levels in monitoring wells at the site. A hydrogeologic cross section of the upper 20 feet of subsurface soils and inferred extent of soil and soil gas contamination at the Hurlburt Field FTA is depicted in Figure 2.2.

2.5 PREVIOUS INVESTIGATIONS

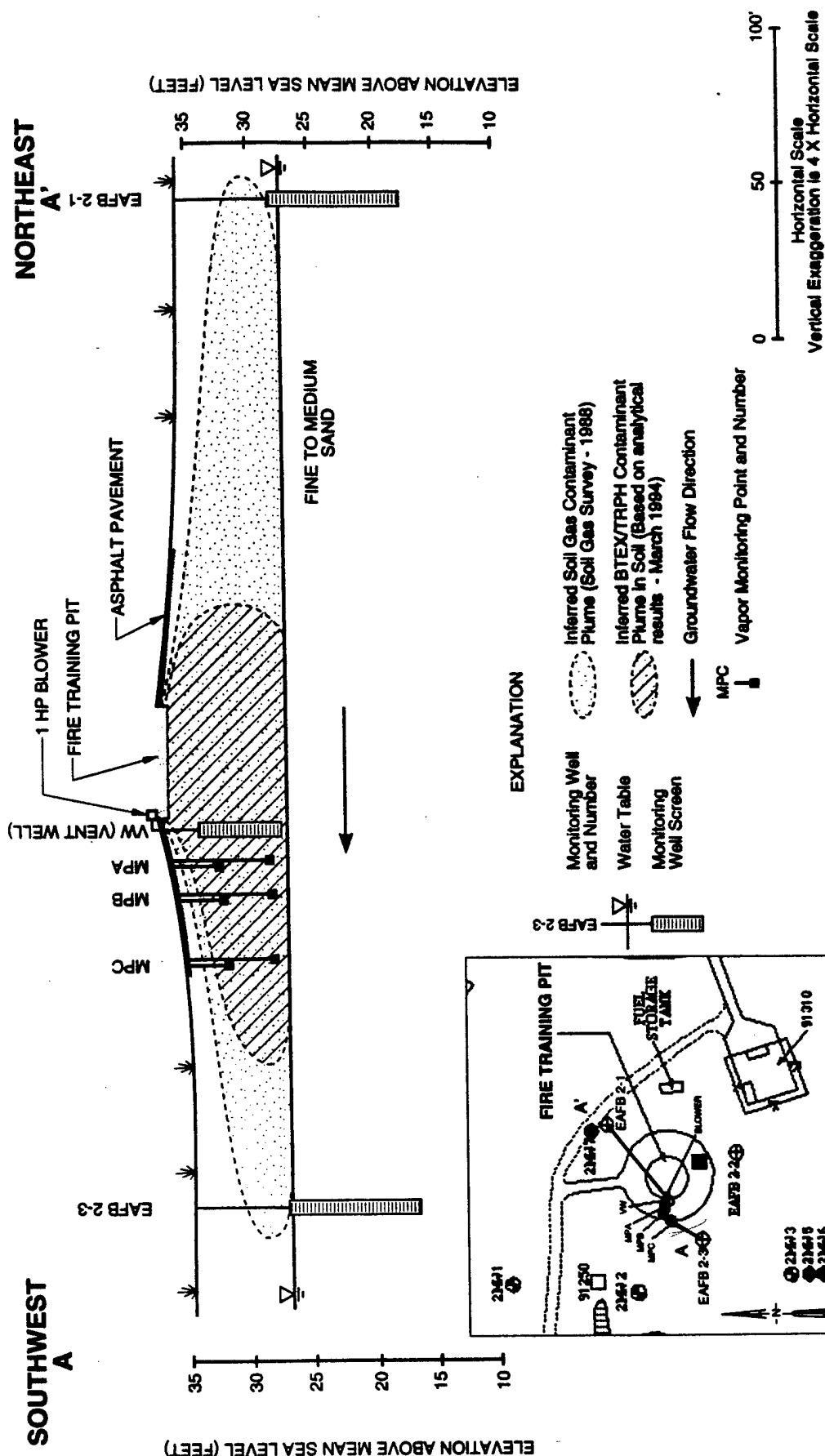
2.5.1 IRP Phase I Investigation

The IRP Phase I investigation was conducted by ES in 1981 to identify the potential for environmental contamination from past waste use and disposal at inactive and active facilities at Eglin AFB. The Hurlburt Field FTA was identified as a potential source for environmental contamination in the investigation. However, the site was not ranked as a high priority for further evaluation (ES, 1981).

2.5.2 IRP Phase II Stage II Investigation

Even though the site was not ranked as a high priority in the Phase I investigation, the site was included in the IRP Phase II, Stage 2 investigation at the request of the Air Force Systems Command (ES, 1988). The investigation included drilling six soil borings (EAFB2-1 through EAFB2-6), converting three of the borings to monitoring wells (EAFB2-1 through EAFB2-3) and collecting groundwater samples from the wells. The monitoring wells were installed around the periphery of the site as shown in Figure 2.1. Each of the wells was less than 20 feet deep and installed in the water table aquifer.

**HYDROGEOLOGIC CROSS-SECTION A - A'
HURLBURT FIELD FIRE TRAINING AREA (FT-39)
EGLIN AFB, FLORIDA**



Water Level as of March 3, 1994

Static groundwater level measurements confirmed the surficial groundwater flow direction was generally northwest toward Hurlburt Lake.

Borings EAFB2-4 through EAFB2-6 were installed at the edge of the asphalt apron (Figure 2.1). Soil samples were collected during drilling of each boring for visual inspection of petroleum contamination. Five of the six boring samples (EAFB2-1, EAFB2-2, EAFB2-4, EAFB2-5, and EAFB2-6) displayed stained soil and/or exhibited strong fuel odors at depths less than 15 feet below ground surface (bgs). Chemical analyses were not performed on soil samples during this field effort.

2.5.3 IRP Phase II Stage III Investigation

The IRP Phase II, Stage 3 field effort began in April 1988 and was designed to obtain additional data to further characterize the site. A soil gas survey was conducted to aid in soil boring and well sitings. This information was used to advance five soil borings (2SB1 through 2SB5) to the soil-water interface and install six monitoring wells (2MW1, 2MW2, 2MW3, 2MW5, 2MW6, and 2MW7). In addition to the sampling of the new monitoring wells, groundwater samples also were collected from the three previously-installed monitoring wells. The locations of the borings and monitoring wells installed during this investigation are presented in Figure 2.1.

The soil gas survey identified the presence of benzene, toluene, and trichloroethene (TCE). Benzene concentrations ranged from non-detect to 512 parts per million, volume per volume (ppmv); toluene concentrations ranged from non-detect to 20.9 ppmv; and TCE concentrations ranged from non-detect to 133.55 ppmv. The distribution of the three compounds were very similar with the highest concentrations found beneath the asphalt apron and extended to the northeast toward monitoring well EAFB2-1. The distribution of toluene in the soil gas is presented in Figure 2.3.

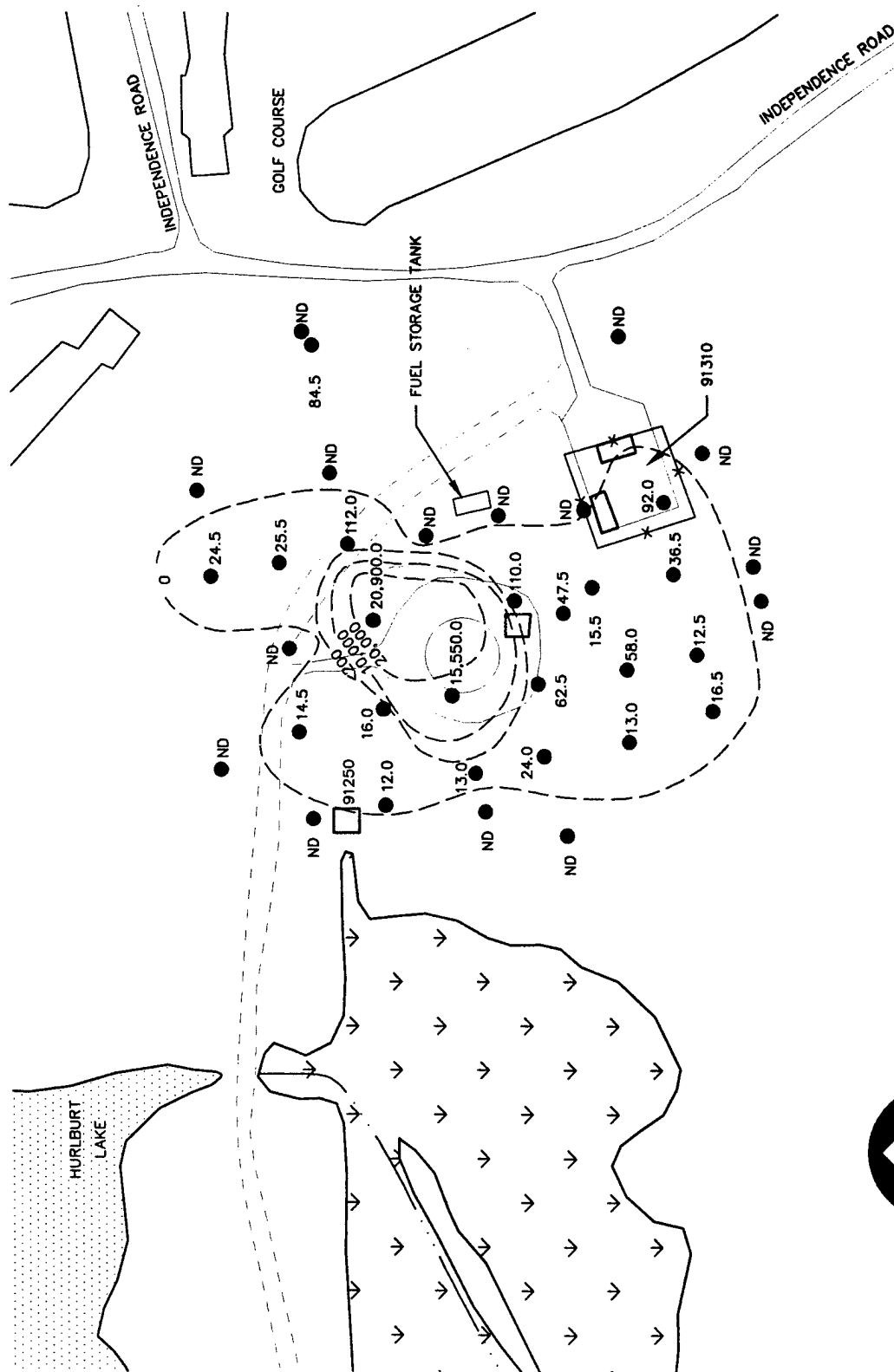
Analytical results for the soil sample from boring 2SB5 revealed the presence of total petroleum hydrocarbons (TPH) at a concentration of 1,900 milligrams per kilogram (mg/kg) and BTEX at a total concentration of 5.12 mg/kg. With exception of a xylenes detection of 0.10 mg/kg in the soil sample from 2SB4, soil samples from soil borings 2SB1 through 2SB4 were free of detectable petroleum hydrocarbon contamination.

2.5.4 Pilot-Scale Bioventing System Installation and Testing

In March 1994, a pilot-scale bioventing system was installed at the site to evaluate the effectiveness of this technology to reduce hydrocarbon concentrations in the vadose zone soils. During installation of the pilot test bioventing system, significant evidence of soil contamination (strong petroleum odor, staining, and elevated photoionization detector [PID] and total hydrocarbon readings) was observed at the boreholes for the VW and VMPs. The inferred extent of soil and soil gas contamination based on previous investigation results and the bioventing pilot test soil and soil gas analyses is depicted in Figure 2.2. Details on the pilot test results are presented in Section 3.

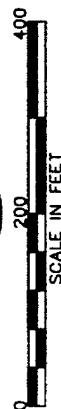
ISOCONCENTRATIONS OF TOLUENE IN SOIL GAS

HURLBURT FIELD FTA - (SITE FT-39)
EGLIN AFB, FLORIDA



LEGEND

- 36.5 PROBE POINT WITH CONCENTRATION IN ppb
- ND NOT DETECTED
- 10,000 --- ISOCENTRATION CONTOURS FOR TOLUENE IN SOIL GAS (ppb) (DASHED WHERE INFERRED)



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PARSONS ENGINEERING SCIENCE, INC.

Figure 2.3

2.5.5 RCRA Facility Investigation

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was performed by O'Brien and Gere in 1995. Analytical results indicated low concentrations of BTEX compounds in the soil and relatively elevated TPH concentration (53,562 mg/kg) (O'Brien and Gere, 1995). TCE was detected in one of the twelve soil samples at a concentration of 0.0032 mg/kg. The BTEX, TPH, and TCE results from this investigation are provided in Table 2.1.

2.5.6 Investigation Summary

Field observations, field screening results, and soil and soil gas analytical results indicate that the majority of the site soils are contaminated from 3 to 8 ft bgs. This indicates that fuel residuals released into the subsurface migrated vertically to the groundwater surface, and were then spread downgradient. Fluctuating groundwater table elevations may have caused a smearing of petroleum hydrocarbons in soils near the water table.

A soil gas survey conducted in 1988 identified the presence of benzene, toluene, and TCE in the soil gas beneath the burn pit and northeast of the burn pit. The most recent soil sample results collected during the RFI in 1995 indicated that ethylbenzene, toluene and xylenes were present at maximum concentrations of 5.95 mg/kg, 0.0073 mg/kg, and 35.2 mg/kg. TCE was also detected at concentrations ranging from non-detect to 0.0032 mg/kg. Soil samples collected from within the radius of influence of the existing VW after 16 months of bioventing indicated remediation of BTEX to non detectable concentrations.

The remaining contaminated areas are outside the radius of influence of the existing pilot-scale bioventing system. The proposed upgrade to the bioventing pilot system is designed to provide the necessary oxygen and stimulate *in situ* biodegradation throughout the remaining contaminated soil.

2.6 REGULATORY INTERPRETATION

FDEP has established a list of risk-based soil cleanup goals for a variety of chemicals. These goals are not enforceable cleanup standards but serve as guidance to aid in making cleanup decisions (FDEP, 1995). Soil cleanup goals for residential and industrial scenarios are listed and are applicable to soils from the ground surface to two feet bgs. For soils below two feet bgs, leachability-based goals are also provided. Historically, the maximum BTEX concentrations were detected in samples collected from 4 to 6 feet bgs (Tables 2.1 and 3.1); therefore, the leachability-based goals apply. The applicable soil cleanup goals are presented in Table 2.2. Based on the 1995 RFI soil results, ethylbenzene and xylenes are present at concentrations above the applicable soil cleanup goals. The proposed system upgrade would provide an effective remedial alternative to reduce the BTEX concentrations to below these goals.

TABLE 2.1
BTEX, TPH, and TCE Concentrations Detected in Soil
Hurlburt Field FTA - (Site FT-39)
Eglin AFB, Florida

Sampling Location	Depth (feet, bgs)	TPH (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Trichloroethene (mg/kg)
SB01	2	NA	ND	0.003U	0.003U	0.003U	0.003U
SB01	4	NA	ND	0.0032U	0.0032U	0.0032U	0.0032
SB02	6	NA	ND	0.35U	0.4937H	3.41H	0.35U
SB03	6	NA	ND	0.0008J	0.0026UJ	0.0026UJ	0.0026U
SB04	4	NA	ND	0.7U	5.95	35.2	0.7U
SB05	0	NA	ND	0.0026J	ND	ND	ND
SB05	2	NA	ND	0.0028U	0.0028U	0.0028U	0.0028U
SB06	0	NA	ND	0.0027U	ND	ND	ND
SB06	2	NA	ND	0.0029U	0.0029U	0.0029U	0.0029U
SB07	4	NA	ND	0.77U	1.45	4.52	0.77U
SB08	6	53,562	ND	0.0138U	0.0138U	0.94	0.0138U
SB09	6	1680J	ND	0.0073J	0.014U	0.014U	0.014U

Notes:

bgs - below ground surface.

mg/kg - milligrams per kilogram.

BTEX compounds were analyzed using Method SW8260

H - Biased High

NA - Not Analyzed.

ND - Not detected. Laboratory reporting limit not available.

U - Not detected above laboratory reporting limits.

J - Estimated value.

Source: O' Brien & Gere, Hurlburt Field FTA Site FT-39 RFI, 1995

TABLE 2.2
Applicable FDEP Soil Cleanup Goals
Hurlburt Field FTA - (Site FT-39)
Eglin AFB, Florida

Chemical	Soil Cleanup Goal ^a (mg/kg) ^c	Maximum Detected Concentration ^b (mg/kg)
Benzene	0.003	ND ^d
Ethylbenzene	0.2	5.95
Toluene	0.2	0.0073J ^e
Xylenes	0.1	35.2
Trichloroethene	0.01	0.0032

Notes:

/a - Leachability-Based Goals (FDEP, 1995)

/b - Using the RFI analytical results (O'Brien and Gere, 1995).

/c - mg/kg - milligrams per kilogram.

/d - ND - Not detected. Laboratory reporting limit not available.

/e - J - Estimated value.

3. BIOVENTING PILOT TEST RESULTS

A bioventing pilot test was performed by Parsons ES at the Hurlburt Field FTA from March 1994 through July 1995. The objectives of the initial bioventing pilot test were to:

- Assess the potential for supplying oxygen throughout the contaminated soil interval;
- To determine the rate at which indigenous microorganisms will degrade fuel when stimulated by oxygen-rich soil gas at this site; and
- To evaluate the potential for sustaining these rates of biodegradation until fuel contamination is remediated below regulatory approved standards.

Because bioventing has been demonstrated to be a feasible technology for this site, the pilot test data were used to design a full-scale remediation system (Section 4) to remediate the soils at the site, minimize potential releases to groundwater/surface water, and lower contaminant concentrations throughout the site to below regulatory standards.

An initial soil gas survey was conducted at the Hurlburt Field FTA in 1994 to select the optimum location for the pilot test. Based on the survey data, a VW and three VMPs were installed. The VW was installed in the area showing the most oxygen depletion (<2 percent), high TVH concentrations (>10,000 ppmv), and elevated carbon dioxide concentrations (>12 percent). The VMPs were installed to monitor the *in situ* biodegradation rates, as well as to determine the radius of oxygen influence of the VW. The locations of the VW, VMPs, and blower are presented in Figure 2.1. Figure 2.2 depicts the hydrogeologic cross section at the Hurlburt Field FTA and provides a profile of the bioventing system.

3.1 SYSTEM CONSTRUCTION

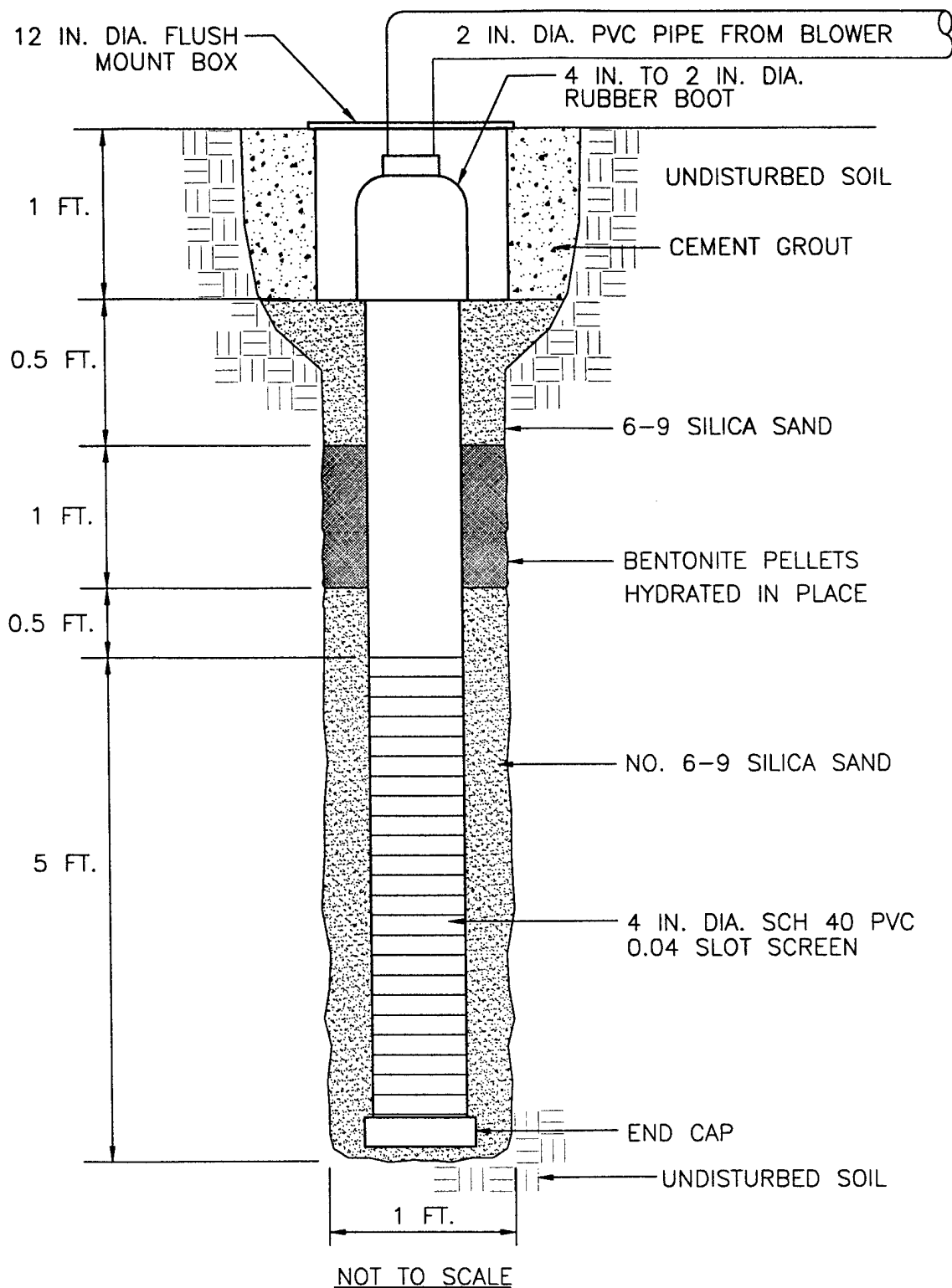
3.1.1 VW Construction

The VW was installed on March 1, 1994 in an area of documented high TPH contamination. The VW was constructed of 4-inch diameter Schedule 40 PVC with a slot size of 0.04 inches. The total depth of the VW was 8.0 feet bgs, with a screened interval from 3 to 8 feet bgs. A construction detail of the VW is presented on Figure 3.1.

3.1.2 Soil Vapor Monitoring Points

Three soil VMPs were installed at 10, 20 and 40 feet radially away from the air injection VW. Each VMP was constructed to provide multiple depth soil gas monitoring with two discrete sample points at 3.5 to 4 feet and 5.5 to 6 feet bgs. A small variation to this sampling interval was made at the outermost VMP because of changes in elevation. Each discrete point was constructed of a 6-inch long piece of 1/2-inch diameter Schedule

INJECTION VW CONSTRUCTION DETAIL HURLBURT FIELD FTA - (SITE FT-39) EGLIN AFB, FLORIDA



40 PVC well screen with 0.02 slot size. The riser of each discrete point was constructed of 1/2-inch Schedule 80 PVC, which extended to approximately six inches bgs.

Additionally, Type K thermocouples with mini connectors were installed at the 4 feet and 6 feet bgs discrete monitoring points in the VMP closest to the VW (MPA). These thermocouples were installed to measure the temperature profile at the site. The top of each VMP was completed with a 12-inch-diameter flush mounted protective well cover set in a concrete base. Figure 3.2 shows the construction of the soil VMP.

3.1.3 Blower Unit Installation

A one-horsepower Gast® regenerative blower unit was installed at the site for the initial and extended pilot tests. The blower was installed in a weather-resistant enclosure and electrically wired for permanent 240-volt, single-phase, 30-amp service. Air from the blower is injected into the VW via a 2-inch-diameter PVC line connected to the blower's exhaust port. At the time of installation the blower unit was injecting air at approximately 7 cubic feet per minute (cfm).

3.2 PILOT TEST SOIL AND SOIL GAS SAMPLING RESULTS

3.2.1 Soil and Soil Gas Sampling Results

Hydrocarbon contamination at the site appears to extend from the ground surface to the groundwater table. Contaminated soils collected by split spoons during the VW and VMP installations were identified based on visual appearance, odor and PID screening. Varying degrees of hydrocarbon staining were encountered throughout the vertical profile in the unsaturated soil zone, and light to strong hydrocarbon odors were noticed in nearly all the split spoon samples. PID readings of greater than 20,000 ppmv were measured in a number of soil samples.

Soil gas samples were collected, prior to performing the air permeability test, in laboratory provided, evacuated Summa® canisters. Soil gas samples were collected from the VW, the 3.5 to 4 feet bgs discrete monitoring point at MPA, and from the 3.5 to 4 feet bgs discrete monitoring point in MPC. All soil gas samples were collected following procedures in the Protocol Document (Hinchee et al, 1992; Downey and Hall, 1994).

Each soil sample was analyzed for TRPH; BTEX; iron; alkalinity; total Kjeldahl nitrogen (TKN); pH; phosphates; percent moisture; and grain size distribution. Soil gas samples were placed in a shipping box (without ice), and shipped via Federal Express® to Air Toxics, Inc., in Folsom, CA for TVH and BTEX analysis. The analytical results for these soil and soil gas samples are presented in Table 3.1.

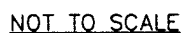


TABLE 3.1
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
HURLBURT FIELD FTA (FT-39)
EGLIN AFB, FLORIDA

Analyte (Units) ^{a/}	Sample Locations-Depth (feet below ground surface)					
	EG3-VW		EG3-MPA-3.5-4		EG3-MPC-3.0-3.5	
	Initial ^{b/}	1-Year ^{c/}	Initial ^{d/}	1-Year	Initial	1-Year ^{d/}
Soil Gas Hydrocarbons						
TVH (ppmv)	14,000	16	12,500	170	26,000	485
Benzene (ppmv)	32	0.03	24	0.19	53	0.33
Toluene (ppmv)	20	0.085	19	0.19	100	0.19
Ethylbenzene (ppmv)	8.5	0.048	6.8	0.12	21	0.067
Xylenes (ppmv)	35	3.4	30	0.5	170	2.2
Soil Hydrocarbons						
	EG3-VW-6-8		EG3-MPA-3-5		EG3-MPB-5	
	Initial ^{e/}	1-Year ^{d/ f/}	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	15,800	8,155	12,100	15,200	848	5,930
Benzene (mg/kg)	< 0.54	< 0.050	< 2.6	< 0.050	< 2.7	< 0.050
Toluene (mg/kg)	15	< 0.050	22	< 0.050	5.1	< 0.050
Ethylbenzene (mg/kg)	3.3	< 0.050	14	< 0.050	4.5	< 0.050
Xylenes (mg/kg)	26	< 0.130	88	< 0.130	29	< 0.130
Moisture (%)	6.9	2.7	5.8	8.6	7.1	6.5

^{a/} TVH=total volatile hydrocarbons: ppmv = parts per million, volume per volume;

TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.

^{b/} Initial soil gas samples collected on March 14, 1994.

^{c/} Final soil gas samples collected on July 23, 1995. Blower system was shut down approximately 30 days

prior to soil gas sampling to allow soil gas to come to equilibrium with soils.

^{d/} Average of primary and duplicate sample. For EG3-MPA-3.5-4, initial sample result reported in Interim Test Results

Report (August 1994) was not averaged with duplicate sample.

^{e/} Initial soil samples collected on March 1, 1994.

^{f/} Final soil samples collected on July 28, 1995.

3.3 PILOT TEST RESULTS

3.3.1 Initial Test

3.3.1.1 Initial Soil Gas Chemistry

Prior to initiating any air injection, soil gas in the VW and all VMPs was sampled for TVH, oxygen, and carbon dioxide. Oxygen depletion was measured around the burn pit. The results of the initial monitoring is presented in Table 3.2.

As shown in Table 3.2, the VW and all VMPs, with the exception of VMPs at two shallow locations (MPA-3.5-4.0 and MPB-3.5-4.0), had completely depleted oxygen levels (0.0 percent), high carbon dioxide readings (greater than 7 percent), and TVH readings ranging from 16,000 ppmv to greater than 20,000 ppmv. These readings suggest that indigenous microorganisms have completely depleted the naturally available oxygen supply, indicating significant biological activity. In contrast, the background monitoring point (EAFB2-1) indicated a high concentration of oxygen (approximately 13 percent oxygen) in the soil gas and less than 6 percent carbon dioxide. These measurements represent the subsurface condition at a depth of about 6 to 8 feet bgs (screen interval estimated above the water table in well EAFB2-1). The measured hydrocarbons concentration was 220 ppmv.

3.3.1.2 Air Permeability

An air permeability test was conducted according to the Protocol Document procedures on 18 March 1994 (Hinchee et al, 1992; Downey and Hall, 1994). Air was injected into the VW for 3 hours at a rate of approximately 13 cubic feet per minute (cfm) and an average pressure of 40 inches of water. Steady-state pressure levels were achieved at all VMPs in approximately 170 minutes. Table 3.3 provides the maximum steady-state pressures at each discrete monitoring point.

Due to the gradual response and relatively lengthy time to achieve steady-state conditions, the dynamic method of determining soil permeability was selected (Hinchee et al., 1992). Using the HyperVentilate® model, an air permeability value ranging from 14 to 150 darcys was calculated for this site. The air permeability, calculated using the steady-state method, was 6.8 darcys. The radius of pressure influence is estimated to exceed 60 feet (ES, 1994).

3.3.1.3 Oxygen Influence

The depth and radius of oxygen influence in the subsurface resulting from air injection into the central VW is the primary design parameter for bioventing systems. Optimization of full-scale and multiple VW systems requires pilot testing to determine the volume of soil that can be oxygenated at a given flow rate and screen configuration.

Based on the oxygen increase and the pressure response observed at all of the monitoring points during the system start-up period, it was estimated that the long-term radius of oxygen influence at the Hurlburt Field FTA will exceed 40 feet when air is injected at a rate of approximately 7 cfm.

TABLE 3.2
INITIAL SOIL GAS CHEMISTRY
HURLBURT FTA (FT-39)
EGLIN AFB, FLORIDA

MP Depth (ft)	O2 (%)	CO2 (%)	TVH (ppm)
EG3-VW-3-8	0.0	9	20,000+
EG3-MPA-3.5-4.0	1.2	7	20,000+
EG3-MPA-5.5-6.0	0.0	8.5	20,000+
EG3-MPB-3.5-4.0	3.5	5.25	16,000
EG3-MPB-5.5-6.0	0.0	7.5	20,000+
EG3-MPC-3.0-3.5	0.0	9	20,000+
EG3-MPC-5.0-5.5	0.0	9	20,000+

TABLE 3.3
MAXIMUM PRESSURE RESPONSE DURING
AIR PERMEABILITY TEST
HURLBURT FTA (FT-39)
EGLIN AFB, FLORIDA

	Distance from injection well (EG3-VW)					
	10' (MPA)		20' (MPB)		40' (MPC)	
Depth (feet)	3.5-4.0	5.5-6.0	3.5-4.0	5.5-6.0	3.0-3.5	5.0-5.5
Time (minutes)	170	170	170	170	170	170
Max Pressure (inches H ₂ O)	11.6	12.2	5.98	7.45	3.09	3.2

3.3.1.4 In-Situ Respiration Rates

Initial *in-situ* respiration tests were performed at the following monitoring points and depths: MPA (5.5 to 6 feet bgs), MPB (5.5 to 6 feet bgs), and MPC (3.0 to 3.5 feet bgs). These points were chosen based on their low oxygen readings (0.0 percent), high carbon dioxide readings (greater than 7 percent), and high TVH readings (greater than 20,000 ppmv). Oxygen utilization rates observed at the site were very consistent and ranged from 0.16 to 0.20 percent per hour.

At Hurlburt Field FTA, an estimated 1,100 milligrams (mg) of fuel per kilogram of soil can be degraded each year. This value is the average of the fuel consumption rates calculated for every point at which a respiration test was conducted. The interval-specific fuel consumption rates were calculated using observed oxygen utilization rates, estimated air-filled porosities, and a conservative ratio of 3.5 mg of oxygen consumed for every 1 mg of fuel biodegraded. The air-filled porosity calculated for each sampling point ranged from 0.17 to 0.18 liters of air per kilogram of soil.

3.3.1.5 Potential Air Emissions

The long-term potential for air emissions from full-scale bioventing operations at the site were considered to be low because of the age and type of the site contaminants (greater than 5 years, and primarily JP4 jet fuel). Additionally, health and safety monitoring conducted during the permeability test using a PID sensitive to 1 ppmv barely exceeded background levels. Because the potential for air emissions is highest during the initial air injection period, and very little emissions were detected, the long-term emission potential is considered low. Current BTEX levels at the site are low, therefore, future BTEX emissions are expected to be negligible. Finally, the site is isolated at Hurlburt Field, and is several hundred feet from any permanently occupied building.

3.3.2 6-Month and 1-Year Bioventing Results

3.3.2.1 System Operation

Upon initial startup of the air injection system at 7 cfm, the oxygen influence was monitored at MPC, 40 feet from the VW. The initial oxygen level at this point was 0 percent. After 24 hours at the 7 cfm injection rate, the oxygen content at MPC had risen to approximately 20 percent. Since sufficient oxygen was being supplied within this 40-foot radius of influence, the air injection flow rate of 7 cfm was maintained throughout the remainder of the 1-year bioventing pilot test study. Weekly system checks were conducted to ensure consistent system operation and performance.

3.3.2.2 In Situ Biodegradation Rates

Initial, 6-month and the 1-year (actually performed after 16-months of operation) *in situ* respiration tests and initial and 1-year final soil sampling events were completed as part of the bioventing pilot test. Table 3.4 shows the estimated fuel degradation rates in

TABLE 3.4
RESPIRATION AND DEGRADATION RATES
HURLBURT FIELD FTA (SITE FT-39)
EGLIN AFB, FLORIDA

Location-Depth (feet below ground surface)	Initial (March 1994)			6-Month (September 1994) ^v			16-Month (July 1995)		
	K _o (% O ₂ /min)	Degradation Rate (mg/kg/year) ^v	Soil Temperature (°C)	K _o (% O ₂ /min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K _o (% O ₂ /min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-S (4')	NS ^v	NS	17.2	0.012	4,100	NS	0.011	3,400	29.8
MPA-D (6')	0.0029	1,000	17.4	0.015	5,200	NS	0.0085	3,000	28.4
MPB-S (4')	NS	NS	NA ^w	0.0042	1,400	NA	0.0042	1,300	NS
MPB-D (6')	0.0026	900	NA	0.0065	2,200	NA	0.0045	1,600	NS
MPC-S (3.5')	0.0034	1,200	NA	0.0051	1,800	NA	0.0051	1,600	NS
MPC-D (5.5')	NS	NS	NA	0.0054	1,900	NA	0.0066	2,300	NS

^v Milligrams of hydrocarbons per kilogram of soil per year.

^v Degradation calculation assumes moisture content of the soil is average of initial and final moistures.

^v NS = Not sampled.

milligrams of TRPH per kilogram of soil per year (mg/kg/yr) at MPA, MPB, and MPC locations, based on the initial, 6-month and 1-year respiration tests.

Initial biodegradation rates ranged from 900 to 1,200 mg/kg/year. After 6 months of bioventing, rates increased to 1,400 to 5,200 mg/kg/year indicating a significant increase in bioactivity (i.e. growth in the bacterial population) since startup of the system. At the end of the 1-year testing period, rates had declined slightly. Biodegradation rates ranged from 1,300 to 3,400 mg/kg/year. The decline in rates at the end of the testing period is probably due to the reduction of fuel (substrate for bacteria) remaining in the soils.

3.3.2.3 1-Year Soil and Soil Gas Sampling Results

Upon completion of the 1-year study, final soil and soil gas samples were collected from the initial sample locations. Table 3.1 shows the initial, and 1-year soil and soil gas laboratory sampling results from the VW, MPA, and MPC locations. As shown on Table 3.1, BTEX and TVH concentrations in soil gas and BTEX concentrations in soil were significantly reduced. However, TRPH concentrations at two of the three sampling locations increased. These increases in concentration may be attributable to spatial variations in TPH concentrations in the soil.

3.3.2.4 Recommendation for Full-Scale Bioventing

Based on the positive results of the 16-month bioventing pilot tests, AFCEE has provided funding for the design and installation of an expanded bioventing system that will remediate remaining contaminated soils at the Hurlburt Field FTA. AFCEE has retained Parsons ES to continue bioventing services at Eglin AFB and to complete the design and installation of an expanded bioventing system. Based on the initial pilot test results, available analytical data, and recently completed soil sampling, Parsons ES has prepared a conceptual full-scale upgrade design that will employ the existing VWs and up to three additional VWs. Six additional VMPs also will be installed to ensure oxygen is being delivered to contaminated soils. During installation of the boreholes for the additional VMPs and VWs, field observations of contamination will be used to determine the necessity of the VWs proposed. Section 4 provides details on the design, construction, and operation of the expanded system. A design package has been prepared for construction of the system and is included in Appendix A of this RAP.

4. EXPANDED BIOVENTING SYSTEM

The purpose of the expanded bioventing system is to provide oxygen to stimulate aerobic biodegradation of the remaining soil contamination present at the Hurlburt Field FTA. Three additional air injection VWs will be used to provide oxygen to the remaining oxygen-depleted, unsaturated and contaminated soils at the site. Two additional VMPs will be installed to ensure that oxygen is being delivered to contaminated soils. System design details are provided in Appendix A.

4.1 OBJECTIVES

Following its installation, the primary objectives for the expanded bioventing system will be to:

- Fully aerate the unsaturated subsurface in areas at the site designated for bioventing remediation;
- Reduce hydrocarbon concentrations in soil to below acceptable regulatory cleanup criteria;
- Eliminate the potential for contamination to migrate and adversely affect groundwater quality at the site by removing the contaminant source from vadose soils; and
- Provide the most cost-effective remediation alternative for petroleum hydrocarbon contaminants at the site.

4.2 BASIS OF DESIGN

Site investigation data, pilot test data, and experience at other bioventing sites provide the main elements of the basis of design. The expanded bioventing system was designed to provide oxygen to areas of significant soil contamination. Both vadose zone and smear zone contaminated soils have been targeted. The design includes installing three VWs and six VMPs.

Pilot test data, such as operating pressure and radius of oxygen influence, were considered during design development. These data were considered in the spacing of VWs and sizing of a full-scale blower system. In addition to the pilot test data from these sites, experience at other sites with similar soil types was considered in design development. Experience at other sites was used only where there were shortcomings in the pilot test data, such as uncertainty in accuracy of the flow rate data.

The significant design parameters and considerations are as follows:

- A radius of oxygen influence of 50 feet was used, resulting in a 100 foot spacing between VWs. However, to effectively treat potentially higher contaminated soils in the area of concern (near the burn pit) VWs have been spaced more closely.
- An air injection pressure of 15 inches of water was assumed in sizing the full-scale bioventing blower. This is consistent with pressures observed during the extended pilot test.
- An air injection flow rate of 7 cfm per VW was assumed based on the pilot test system performance and experience at other sites.

The locations of the six additional VMPs were selected such that they would provide information as to the extent of smear zone contamination, would be useful in evaluating the magnitude of contaminant reduction through soil gas sampling, and would provide important oxygen influence data. The proposed VMPs both will be located near potential "dead zones" and on the periphery of the design radius of oxygen influence (Figure 4.1).

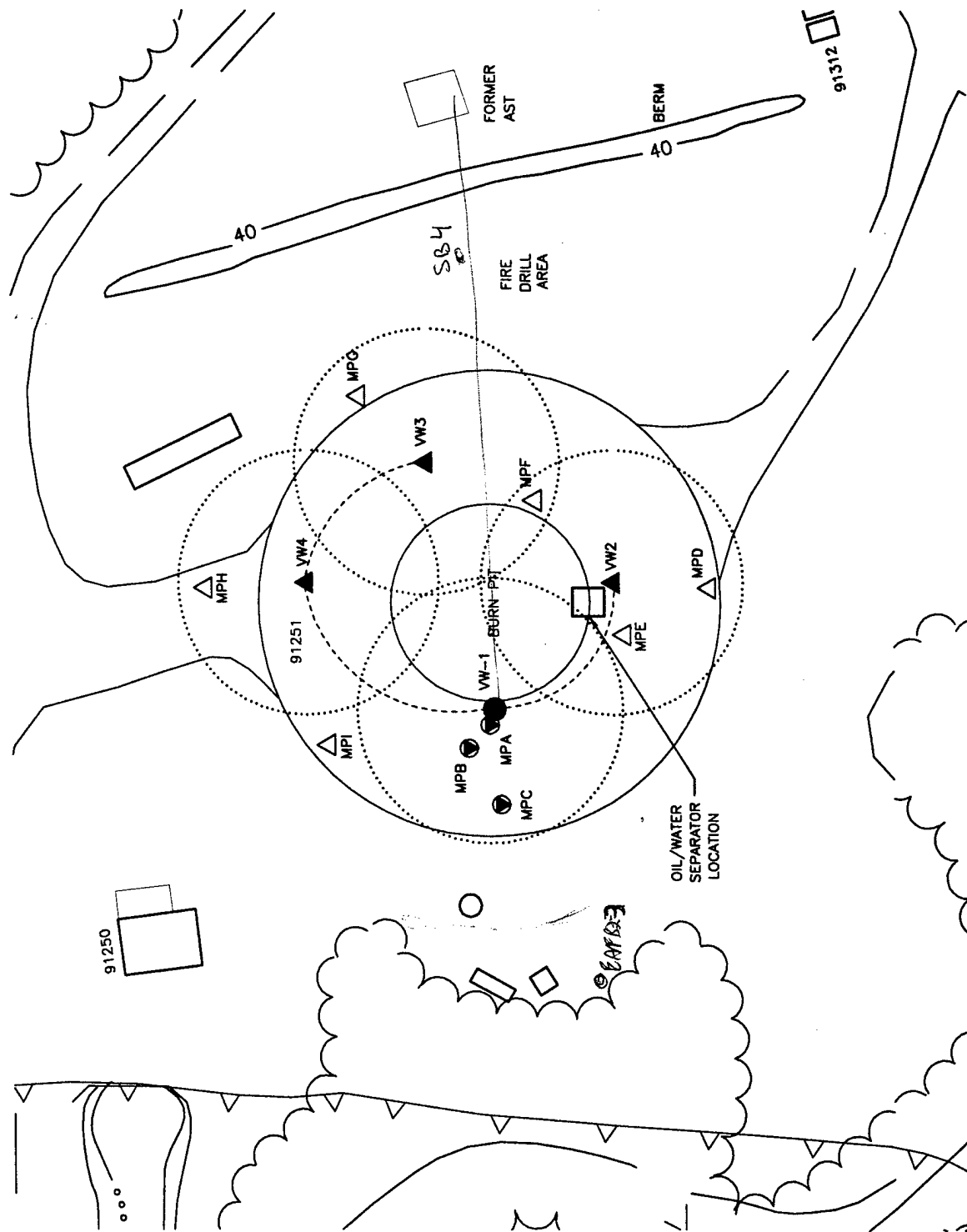
4.3 SYSTEM DESIGN

The proposed upgrade to the existing bioventing system will incorporate the existing VW and up to three new VWs. Six new VMPs will also be constructed to monitor soil gas at the site. The additional VWs will be installed to ensure proper oxygen influence throughout the area of the soil contamination. The new VWs will be 2 inches in diameter and will be screened with 0.040-inch slot from 3 to 8 feet bgs. Figure 4.1 shows the proposed locations of the existing and new VWs and VMPs with the estimated radius of influence. The piping from the blower to the new VWs will be installed below ground. Design details are included in the design package provided in Appendix A.

The VWs will be manifolded using 1.5-inch-diameter, high density polyethylene (HDPE) piping as the conduit for the injected air to flow from the blower to the proposed VWs. The piping will be connected to the new 1.0 HP regenerative blower and will be set inside a new weather-proof enclosure. A separate (manual) flow control valve and flow measurement port will be included in the lines connecting each VW to allow adjustment of the air flow to each VW.

Based on experience at other bioventing sites, a maximum injection rate of 7 cfm at each VW should be sufficient to supply oxygen to the remaining contaminated soils and sustain *in situ* fuel biodegradation. The radius of oxygen influence around each VW was estimated to extend greater than 40 feet based on the data collected during the initial pilot testing. The VW locations were selected to make use of existing VMPs and to provide coverage of contaminated soils. A spacing of approximately 90 feet (not-to-exceed distance) between VWs is planned.

PROPOSED FULL SCALE SYSTEM CONFIGURATION **HURLBURT FIELD FTA - (SITE FT-39)** **EGLIN AFB, FLORIDA**



SOURCE: O'BRIEN & GERE, RFI REPORT, 1995



PARSONS ENGINEERING SCIENCE, INC.

4.4 PROJECT SCHEDULE

Following review and approval of the system upgrade RAP by AFCEE/ERT, Eglin AFB, and the Florida Department of Environmental Protection (FDEP), field work will begin. The project schedule, presented on Figure 4.2, for the upgrade is contingent upon timely approval of this RAP.

4.5 SYSTEM OPERATION AND MONITORING

Following system installation, an Operation and Maintenance (O&M) plan and record system drawings will be prepared.

4.5.1 System Operation

At startup of the full-scale system, it will be necessary to optimize the air injection rate and to ensure proper operation of the blower system. Flow rate optimization is accomplished by gradually increasing the flow rate to each VW until soil gas oxygen concentrations at all VMP depth intervals reach a minimum concentration of approximately 10 percent. Oxygen levels in excess of 10 percent at the outer VMPs may indicate that the volume of air passing through the soil exceeds the biological oxygen utilization. The blower will be checked to ensure that it is producing the required flow rate and pressure for air injection.

O&M requirements for the proposed bioventing system are minimal. The regenerative blowers are virtually maintenance-free. The only recurring maintenance required is a monthly check of the air filter, which is generally replaced when a pressure difference of 10 to 15 inches of water across the inlet filter is reached. The time period between filter changes is dependent on site conditions, and is typically every 3 to 6 months. The O&M manual will further detail operation requirements.

4.5.2 System Monitoring

Monitoring of the bioventing system will include system checks of blower operation, including outlet pressures, inlet vacuum, and exhaust temperature every 2 weeks. These system checks will be performed by Eglin AFB technicians.

Soil samples will be collected from all boreholes advanced during drilling activities for installation of the full-scale bioventing system components. Samples will be collected at 2.5-foot intervals, and will be screened in the field for organic vapors using a OVA. Five soil samples will be sent to an analytical laboratory for analysis of BTEX by U.S. Environmental Protection Agency (USEPA) Method SW8020 and TRPH by USEPA Method 8015 modified. These samples will be collected from the boreholes advanced for the VMPs if significant contamination is encountered at these locations.

Soil gas sampling will be conducted at all VMPs and VWs prior to system startup to establish baseline oxygen, carbon dioxide, and TVH levels using field instruments. In addition, soil gas samples from five locations will be forwarded to an analytical laboratory for analysis of TVH and BTEX by USEPA Method TO-3. The locations of these samples will be determined based on the field screening results. The five intervals

Schedule of Activities

ID	Task Name	Duration	Start	Finish	1996				1997				
					Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4
1	Hurlburt Field FTA	420d	7/15/96	2/20/98									
2	Draft RAP Preparation	31d	7/15/96	8/26/96									
3	Deliver Draft RAP to AFCEE and Eglin AFB	0d	8/26/96	8/26/96									
4	Review and Comment	20d	8/27/96	9/23/96									
5	Deliver Final RAP to AFCEE, Eglin AFB, and FDEP	0d	9/23/96	9/23/96									
6	Regulatory Review	20d	9/24/96	10/21/96									
7	Regulatory Approval	0d	10/21/96	10/21/96									
8	Field Mobilization	6d	10/22/96	10/29/96									
9	Construction of System Upgrade	14d	10/30/96	11/18/96									
10	System Start-up and Shakedown	3d	11/19/96	11/21/96									
11	Preparation of O&M Manual	21d	11/22/96	12/20/96									
12	Deliver Manual to AFCEE and Base	0d	12/20/96	12/20/96									
13	Review and Comment	25d	12/23/96	1/24/97									
14	Deliver Final O&M Manual to AFCEE, Base, and FDEP	0d	1/24/97	1/24/97									
15	O&M Effort	215d	1/27/97	11/21/97									
16	One Year Sampling	5d	11/24/97	11/28/97									
17	One Year Monitoring Report	60d	12/1/97	2/20/98									

Figure 4.2

Task	Progress	Milestone
1. Define project goals and objectives	100%	Project Kick-off
2. Conduct market research and analysis	80%	Market Research Report
3. Develop a business plan	60%	Business Plan Draft
4. Secure funding and resources	40%	Funding Secured
5. Hire and train staff	20%	Staff Hiring Complete
6. Launch the product/service	10%	Product Launch

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23/96

Project	
Date	

exhibiting the highest TVH concentrations based on field instruments will be sampled for laboratory analysis.

Following startup and optimization of the bioventing system, Parsons ES personnel will remain on site to ensure that adequate oxygen influence has been achieved. System performance monitoring by Parsons ES under Option 1 of the Extended Bioventing Project will include *in situ* respiration testing during a site visit after 1 year of full-scale system operation. Soil gas samples will also be collected from the same five points sampled during full-scale system installation and reanalyzed for BTEX and TVH using USEPA Method TO-3. No soil sampling will be performed under Option 1 of the Extended Bioventing Project.

Prior to performing the 1-year respiration tests and soil gas sampling, the blower will be turned off for 30 days to allow soil gas to equilibrate so that 1-year data can be compared to initial soil gas data. Air will be injected into VWs or VMPs for 20 hours, and then shut off. Oxygen uptake will be monitored in the VMPs for approximately 72 hours to measure the rate at which oxygen decreases in the soil gas. These data will then be used to estimate the current biodegradation rates and to evaluate the progress of contaminant removal and system effectiveness. As the fuel in the soil is depleted, the respiration activity of the indigenous microorganisms is reduced, and slower oxygen utilization rates will be measured. The use of oxygen utilization and soil gas chemistry as indicators of remaining contaminant concentration decreases the likelihood of premature closure soil sampling events.

System monitoring and *in situ* respiration test data will be analyzed to determine the progress of soil remediation. Estimates of contaminant reduction and time remaining to complete soil remediation will be based on the data collected during the respiration tests (oxygen utilization rates), quantitative estimates of the long-term biodegradation rates, and decreases in soil gas concentrations. If soil gas data indicate that the soils have been sufficiently remediated, closure soil sampling may be recommended.

The monitoring schedule for the full-scale system will be as follows:

Event	Frequency
Blower Vacuum/Pressures and Temperatures	Bi-weekly
Respiration Testing	Annually
Soil Gas Sampling	Annually

5. HANDLING OF INVESTIGATION-DERIVED WASTES

All soil cuttings will be containerized in drums staged at the site. Following completion of drilling activities, the Eglin AFB contact will be notified. It is anticipated that less than 10 cubic yards of soil cuttings will be generated during installation of the full-scale bioventing system.

Decontamination of augers, sampling equipment, and all other items requiring decontamination will be performed at a temporary decontamination area set up at the site. Decontamination water will be placed in 55-gallon drums and stored at the site. Eglin AFB will be responsible for ultimate disposal of all the drummed waste.

6. BASE SUPPORT REQUIREMENTS

The following support from Eglin AFB is needed prior to the arrival of the drillers and the Parsons ES team:

- Assistance in obtaining a Base digging permit.
- Obtaining all necessary regulatory permits for the VWs and VMPs.
- Assistance in obtaining any air permits required.
- Provide a copy of any Base soils management plan (SMP) and/or sampling and analytical procedures (SAP) plan.
- Provide any paperwork required to obtain gate passes and security badges for drilling personnel and two Parsons ES employees. If required by the Base, vehicle passes will be needed for two Parsons ES trucks, one drill rig, and two drilling support trucks. These passes must be valid for the expected duration of drilling operations (about 1 week) and the full-scale system installation and startup (about 3 weeks).
- A potable water supply for well construction and decontamination activities.

During full-scale bioventing, Base personnel will be required to check the blower systems once every 2 weeks to ensure that they are operating properly, record air injection pressures and temperatures, and replace air filters, as needed. Parsons ES will provide a maintenance procedures manual and a brief training session.

- If the blower stops working, notify Mr. Steve Ratzlaff of Parsons ES at (404) 235-2361, Mr. John Ratz of Parsons ES - Denver at (303) 831-8100, or Captain Ed Marchand of AFCEE at (210) 536-4364.
- Arrange site access for a Parsons ES technician to conduct respiration testing and soil gas sampling approximately 1 year after full-scale system installation and start up.

7. POINTS OF CONTACT

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APPENDIX A
DESIGN PACKAGE

CONSTRUCTION DRAWINGS FOR

EXPANDED BIOVENTING SYSTEM

HURLBURT FIELD FTA

EGLIN AIR FORCE BASE

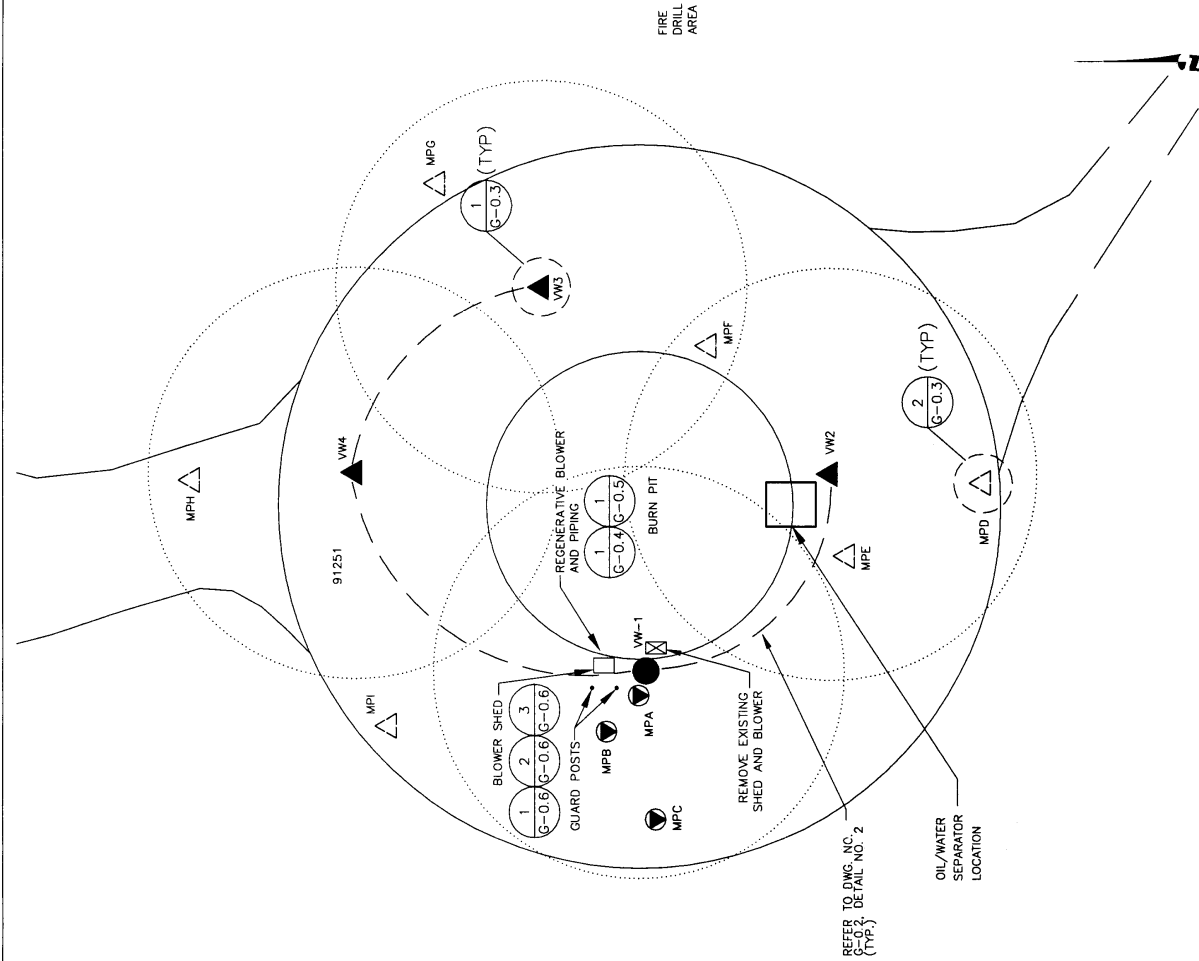
PREPARED FOR

AFCEE

AUGUST 1996

DRAWING INDEX

DRAWING NO.	DRAWING NAME
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAIL
G-0.3	VENT WELL AND MONITORING POINT STANDARD DETAILS
G-0.4	BLOWER P & ID
G-0.5	BLOWER PIPING LAYOUT DETAIL
G-0.6	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAIL



SITE LAYOUT
SCALE: 1"=30'

DRAWING NO. G-0.1 REV. B		TITLE SHEET AND SITE LAYOUT	
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)		EXPANDED BIOVENTING SYSTEM HURLBURT FIELD FTA EGLIN AIR FORCE BASE	
PARSONS ENGINEERING SCIENCE, INC. Atlanta, Georgia (404) 235-2300		Job No. 726876-43242 Designed RKF Drawn M/W Checked Reviewed Approved Reg. No. Date	
Rev. A Date 8/6/96 Description 65% DESIGN		By	

ABBREVIATIONS

A/I	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
AT	AT
CBM	CENTER BACK MOUNT
CFM	CUBIC FEET PER MINUTE
CLR	CLEAR
D/A	DIAMETER
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE
le	FOR EXAMPLE
LM	LOWER MOUNT
MAX	MAXIMUM
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO. #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
PRO	PROPOSED WELL
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
ST STL	STAINLESS STEEL
TYP	TYPICAL
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W/	WITH
WN	WELD NECK
WNF	WELDED WIRE FABRIC
MPA	EXISTING BIOVENTING MONITORING POINT
MPD	PROPOSED BIOVENTING MONITORING POINT
VW-1	EXISTING VENT WELL
VW-2	PROPOSED VENT WELL
	PROPOSED HEADER PIPE TO VENT WELL

SECTION DESIGNATION	SECTION NAME
A	SECTION CUT
X	SCALE: NTS
DRAWING OF ORIGIN	SCALE
DETAIL NO	DETAIL NAME
1	DETAIL DESCRIPTION
X	SCALE: NTS
DRAWING OF ORIGIN	SCALE

MATERIAL LEGEND

	ASPHALT
	BENTONITE
	BENTONITE/CEMENT GROUT
	BENTONITE PELLETS
	BUILDING (EXISTING)
	COMPACT(3) BACKFILL
	COMPACT(3) BASE STONE
	CONCRETE
	PEA GRAVEL
	SAND
	UNDISTURBED SOIL

PIPE MATERIAL

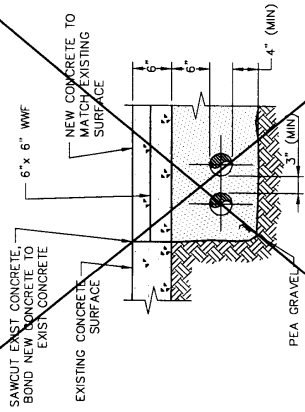
CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

PIPE SERVICE

A/I	AIR INJECTION
B/V	BIOVENTING
DR	DRAIN

SYMBOLS

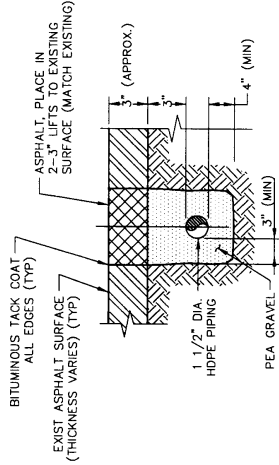
	EXISTING BIOVENTING MONITORING POINT
	PROPOSED BIOVENTING MONITORING POINT
	EXISTING VENT WELL
	PROPOSED VENT WELL
	PROPOSED HEADER PIPE TO VENT WELL



CONCRETE REPLACEMENT DETAIL

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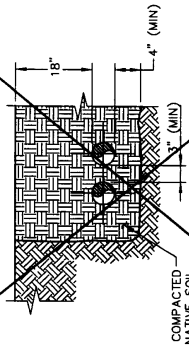
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ASPHALT REPLACEMENT DETAIL

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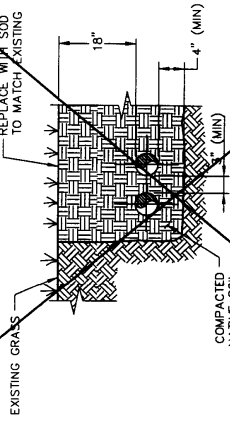
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SOIL COVER REPLACEMENT DETAIL

SCALE: NTS

3



GRASS COVER REPLACEMENT DETAIL

SCALE: NTS

4

LEGEND AND STANDARD TRENCH DETAILS

DRAWING NO. G-0.2

REV. A

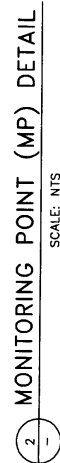
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM
HURLBURT FIELD FLA
EOLIN AIR FORCE BASE

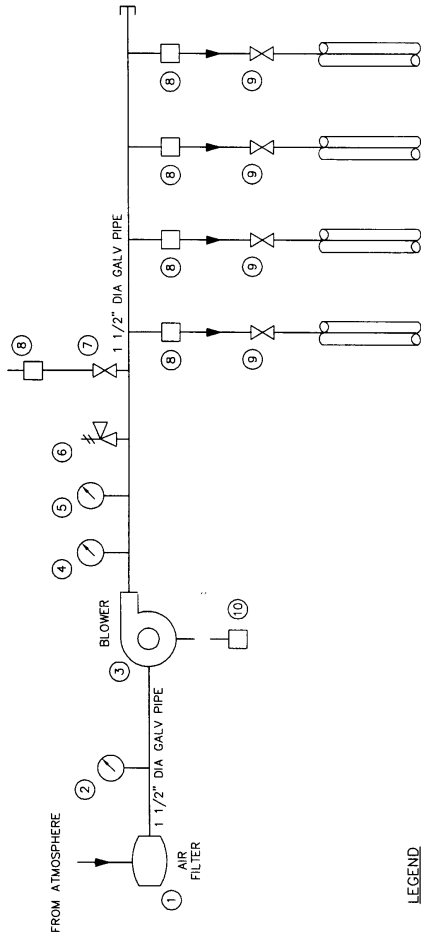
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Atlanta, Georgia
(404) 235-2300

Job No. 726876 A242Z
Designed RAF
Drawn MM
Checked
Reviewed
Approved
Reg No.

Date
Rev
A
8/6/96
Description
55% DESIGN

DRAWING NO	REV
G-0.3	A





LEGEND

- ① INLET AIR FILTER – SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P
- ② VACUUM GAUGE – GAST[®] 2 5/8" DIA, 0-60" H₂O, 1/4" NPT, LM (Part No. AJ497)
- ③ BLOWER – GAST[®] 1.0HP R4110N-50, 78 CFM AT 15" H₂O PRESSURE
- ④ TEMPERATURE GAUGE – ASHCROFT, 0-250°F, 1/2" NPT, CBM (Part No. 24066 FROM ORANGER)
- ⑤ PRESSURE GAUGE – WKA 61110, 2 1/2" DIA., 0-60" H₂O, 1/4" NPT, LM (Part No. 9851704)
- ⑥ AUTOMATIC PRESSURE RELIEF VALVE – GAST AG25B, SET TO RELEASE AT 40" H₂O PRESSURE
- ⑦ MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE
- ⑧ FLOW MEASURING PORT FITTED WITH PLUG (1/4" x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)
- ⑨ FLOW CONTROL VALVE – 1 1/2" GATE
- ⑩ FUSED DISCONNECT SWITCH

BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

DATE	REV	DESCRIPTION	BY
08/09/96	A	05X DESIGN	
		Approved	
		Reviewed	
		Checked	
		Drawn	
		Designed	
		Job No.	72876.4242

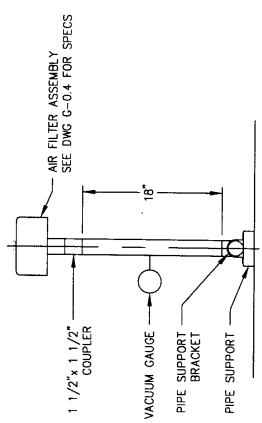
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ENGINEERING SCIENCE, INC.
Atlanta, Georgia
(404) 235-2300

AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE
(AFCEE)
EXPANDED BIOVENTING SYSTEM
HURLBURT FIELD FTA
EGLIN AIR FORCE BASE

DRAWING NO
G-0.5
REV
A

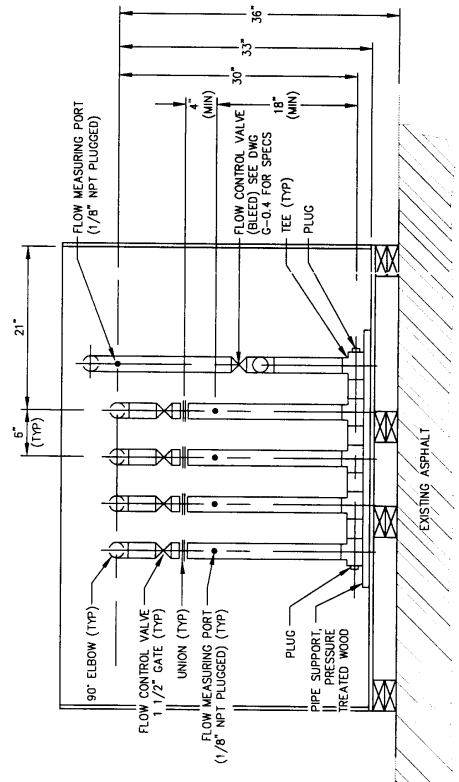
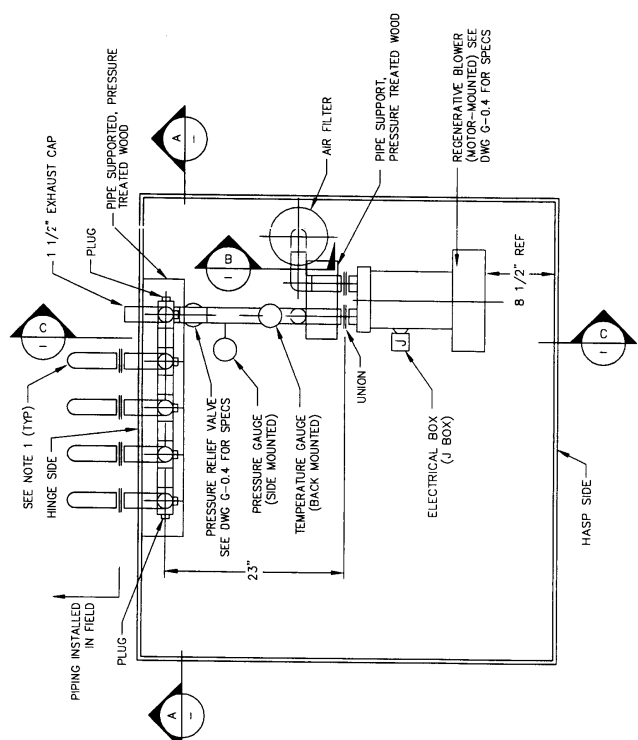
BLOWER PIPING
LAYOUT DETAIL

- NOTES:
1. SHOP CORE HOLES TO PIPING DIMENSIONS
 2. ALL PIPING 1 1/2" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
 3. SEE DRAWING G-0.6 FOR BLOWER BUILDING DETAILS

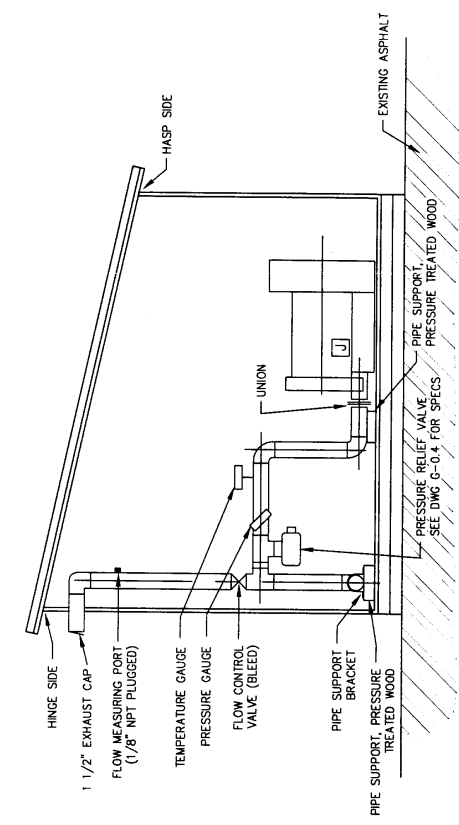


B BLOWER INLET PIPING SECTION
3/4" = 1'-0"

1 BLOWER PIPING LAYOUT PLAN DETAIL
3/4" = 1'-0"



A MANIFOLD DETAIL SECTION
3/4" = 1'-0"



C BLOWER OUTLET PIPING SECTION
3/4" = 1'-0"

Blower Shed Field Installation Detail		Rev	A
Blower Shed Field Installation Detail		Drawing No	G-0.6
CONSTRUCTION DETAILS		Rev	
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)		Rev	
EXPANDED BIOVENTING SYSTEM		Rev	
HURLBURT FIELD FTA		Rev	
ECLIN AIR FORCE BASE		Rev	
PARSONS ENGINEERING SCIENCE, INC.		Rev	
Atlanta, Georgia (404) 235-2300		Rev	
Job No. 726876.43242		Rev	
Designed RAF		Rev	
Drawn MW		Rev	
Checked		Rev	
Reviewed		Rev	
Approved		Rev	
Reg No		Rev	
Date		Rev	
Rev		Rev	
Date		Rev	
Description		Rev	
By		Rev	

